SUMMARY OF RESEARCH - FY 82

RESEARCH SECTION

DIVISION OF PLANNING AND PROGRAMMING

ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

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Robert W. Ward	Commissioner
John C. Bates	Deputy Commissioner, Planning and Programming
Robert Venusti	Director, Division of Planning and Programming, Interior Region

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FOREWORD

During the past year Alaskan Senators Frank Murkowski and Ted Stevens introduced into the U.S. Congress a bill calling for the formulation of a national research policy for the Arctic. This legislation will set the stage for the coordination of research at both the national and state levels and will be a positive step toward recognizing the national importance of northern regions and Alaska in particular. Although a national Arctic research policy is desirable, the progress the State of Alaska has already made in addressing its own scientific and technological problems should not be overlooked.

The Alaska Council on Science and Technology, created in 1978, is now becoming a focal point in the process of integrating the state's research interests. Traditionally, the University of Alaska, through its research institutes, has carried out the bulk of the basic research done in Alaska, with direct federal funding and state funds.

The Research Section of the Department of Transportation and Public Facilities (DOTPF) has directed its efforts toward applied research in the fields of transportation and building technology. Developed over the past five years, the Research Section has built a program dictated by the Department's need to solve practical engineering problems posed by the unique Alaskan environment. The Research Section of the DOTPF presently directs the largest single program of applied research in the state. Private sector consultants and University faculty are actively engaged in projects with DOTPF engineers in joint efforts to find solutions to problems of design and construction and the maintenance and operation of state facilities.

The staff of the Research Section is continuing to search for solutions to the unique technical problems facing Alaskans. As state and federal research policies evolve, our applied research efforts will be coordinated within those frameworks. In the following pages the details of our work over the past year are described. Through this research some questions have been answered and new questions have arisen.

Larry Sweet
Research Manager

SECTION 1
OBJECTIVE

The Department of Transportation and Public Facilities (DOTPF) has the mission of planning, building, and maintaining the greater portion of the transportation systems and state-owned facilities in Alaska. This task is complex and requires special knowledge of the unique Alaskan environment in a variety of technical disciplines.

The Research Section of the Division of Planning and Programming was created to support the technical framework of the operational divisions of the department. The objective of the section is to develop new technical knowledge to improve the department's capability to carry out the assigned mission. The goals of the Research Section are to reduce costs, improve efficiency, and increase serviceability of state facilities and transportation systems by better understanding the materials and methods and the environment in which they are used.

Research is performed by staff engineers, consultants in the private sector, University of Alaska faculty, and other government agencies.

At the present time the Research Section is engaged in a broad spectrum of investigations that include highways, buildings and energy-related problems, transportation systems research, and airport and aviation investigations.

SECTION 2
RESEARCH IN PROGRESS

SUMMARY OF RESEARCH PROJECTS

HIGHWAY RESEARCH PROGRAM

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. McHattie/ Woodward-Clyde Consultants	Highway Life Cycle Costing	State	2 years 9/82
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Stabilized Soils Study	State	3 years 6/83
R. McHattie/ Oregon State University	Resilient Soil Properties Study	State	3 years 6/83
D. Esch/ Petroleum Engineering Department, University of Alaska	Snow and Ice Control Study	State	3 years 12/82
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Permafrost Culverts Study	State	3 years 6/83
B. Connor/ Boeing Computer Services Washington State DOT	Engineering Computer Software	State	3 years 6/83
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Pavement Thermal Study	State	3 years 6/83
B. Connor/ Shannon & Wilson, Inc.	Roadway Strength Inventory	State	2 years 6/83

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
D. Esch/ School of Mineral Industry, University of Alaska	Frost Heave Test Development	State	3 years 12/83
R. McHattie/ Geophysical Institute, University of Alaska	Low Temperature Thermal Cracking Studies	State	2 years 6/83
B. Connor/ Geophysical Institute, University of Alaska	Thermal Analysis Computer Modeling	State	3 years 12/83
B. Connor/ Mechanical Engineering Department, University of Alaska	Solar-Assisted Culvert Thawing Devices	State	3 years 2/83
D. Esch	Prethawing of Permafrost by Surface Modifications	FHWA	3 years 6/82
R. Jurick/ Geophysical Institute, University of Alaska	Field Evaluation Site for Ground Ice Detection	FHWA	2 years 10/82
S. Kailing/ Institute of Water Resources, University of Alaska	Fish Passage Through Drainage Structures	FHWA	3 years 6/84
S. Kailing/ Institute of Water Resources, University of Alaska	Aspects of Streamflow with Regard to Fish Passage	FHWA	2 years 6/84
R. McHattie/ Shannon & Wilson, Inc.	Correlating Dynamic Deflections with Pavement Performance	FHWA	2 years 12/82
B. Connor/ Mechanical Engineering Department, University of Alaska	Evaluation of Air Duct Ground Stabilization System	FHWA	2 years 12/82

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. Jurick/ Geophysical Institute, University of Alaska	Geophysical Methods for Detecting Permafrost and Ground Ice	FHWA	2 years 10/82
D. Esch/ Civil Engineering Department, University of Alaska Bell, Herring & Assoc.	Permafrost Research Site Monitoring	FHWA	2 years 6/83
D. Esch E. Johnson	Applications of Engineering Fabrics in Alaska	FHWA	3 years 12/82
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory Civil Engineering Department, University of Alaska	Ice Forces on Northern River Bridges	FHWA	4 years 6/82
R. McHattie/ Oregon State University	Mechanistic Design Methods for Alaskan Pavements	FHWA	2 years 9/82
D. Esch/ Geophysical Institute & Civil Engineering Department, University of Alaska	Portable Powered Probe for Permafrost	FHWA	1 year 6/82
D. Esch F. Narusch	Rubberized Asphalt for Roadway Ice Control	FHWA	3 years 7/82
D. Esch	Soil Stabilization for Remote Area Roads	FHWA	2 years 5/82
D. Esch	Optimum Sand Specifications for Roadway Ice Control	FHWA	2 years 5/82
R. McHattie	Reliability of the Alaskan Pavement Rating Procedure	FHWA	2 years 6/82

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. McHattie	Evaluation of Road Rater Test Methods	FHWA	2 years 8/82
R. McHattie M. Reckard	Economic Aspects of High Speed Unpaved Roads	FHWA	2 years 9/82
D. Esch/ Civil Engineering Department, University of Alaska	Design Guide for Pavements Over Permafrost	FHWA	2 years 6/82
D. Esch/ Civil Engineering Department, University of Alaska	Design Manual for Roadways Over Muskeg	FHWA	2 years 6/82
D. Esch/ Civil Engineering Department, University of Alaska	Stress Monitoring of New Gastineau Channel Bridge	FHWA	3 years 6/83
B. Connor/ Geophysical Institute, University of Alaska	Remote Monitoring of Springtime Thaw Depths	FHWA	2 years 6/83
D. Esch/ Geophysical Institute, University of Alaska	4th International Conference on Permafrost	FHWA	3 years 6/84
B. Connor	Asphalt Surface Treatment (AST) Design	FHWA	2 years 6/83
D. Esch/ U.S.A. Cold Regions Research and Engineering Laboratory	Bridge Construction on Permafrost	FHWA	2 years 6/83
C. Gentry/ Harding Lawson, Inc. VECO, Inc.	Use of Preheated Maintenance Sand for Skid Control	FHWA	2 years 3/84

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
C. Gentry/ USKH Consultants, Inc.	Highway Thaw/Settlement Control	FHWA	2 years 6/84
R. McHattie	Evaluation of AC-1.75 Asphalt	FHWA	2 years 6/84
B. Connor	Decision Criteria for Seal Coating	FHWA	2 years 6/83

ENERGY AND BUILDINGS RESEARCH PROGRAM

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. Jurick/ Institute of Water Resources & Mechanical Engineering Department, University of Alaska Janet Matheson, Architect, Inc. J.S. Strandberg Consulting Engineers Charles Bettisworth & Company Fairbanks North Star Borough	Passive Solar Alaskan School	U.S.D.O.E. & State	4 years 2/84
L. Leonard/ Mechanical Engineering Department, University of Alaska J.S. Strandberg Consulting Engineers Crews, MacInnes & Hoffman, Engineering Consultants	Thermal Performance Standards for State Buildings	State	3 years 6/83
L. Leonard L. Hegdal, J. Rezek, S. Kailing/ Mechanical Engineering Department, University of Alaska J.S. Strandberg Consulting Engineers Sunfair Engineering, Inc.	Buildings Energy Conservation Studies	State	2 years Ongoing

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. Jurick/ Mechanical Engineering & Electrical Engineering Departments, University of Alaska J.S. Strandberg Consulting Engineers	Remote Facilities Monitoring	State	3 years 12/83
L. Leonard J. Malosh	Fuel Cell Evaluation	State	3 years 6/83
L. Leonard/ Geology Department, University of Alaska	Gas-Sorptive Properties of Zeolite Mordenite	State	2 years 12/81
J. Rezek/ Mechanical Engineering Department, University of Alaska	Small-Scale Heat Recovery	State	3 years 12/82
L. Hegdal J. Rezek, M. Reckard	Use of Sun Spaces in Alaska	State/ Rural Cap.	2 years 12/82
J. Rezek	Roofing Design and Materials Investigation	State	2 years 6/83
R. Jurick/ Electrical Engineering Department, University of Alaska	Digital Telemetry (Meteor Burst)	State	3 years 12/83
S. Kailing/ Alaska Department of Environmental Conservation	Vehicle Emission Effects on Air Quality	State	3 years 6/83
J. Rezek/ City of Bethel	Fire Protection in Bush Areas	State	2 years 6/82
S. Kailing	Public Facilities Building Codes	State	2 years 6/83

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
L. Hegdal	Public Building Life Cycle Costing	State	2 years 12/82
L. Hegdal	Utility Freeze Protection	State	2 years 12/82
J. Rezek	Gasohol and Alcohol as Vehicle Fuel	FHWA	2 years 6/81

TRANSPORTATION SYSTEMS RESEARCH PROGRAM

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. Miller L. Leonard/ Ormat Turbine Systems	Noorvik Airport Lighting Demonstration	State/ FAA	2 years 9/82
J. Swift/ United Hover, Inc.	Air Cushion Vehicle (ACV) Demonstration Project	State UMTA	3 years 10/81
R. Miller J. Swift/ LGL Alaska	Air Cushion Vehicle (ACV) Environmental Impact Study	State	2 years 12/81
R. Miller/ Woodward-Clyde Consultants	Paint Performance Testing	State	3 years 6/83
R. Miller D. Coatney	Anchorage Traffic Computer System Improvements	State	3 years 3/82
R. Miller/ Peratrovich & Nottingham, Inc.	Utilization of Yukon River Bridge for Gas Pipeline Crossing	State	2 years 3/82
R. Miller/ Peratrovich & Nottingham, Inc.	Transportation Research Projects	State	2 years 6/83

Project Manager/ Consultant	Project	Funding Agency	Duration/ Compl. Date
R. Miller/ TRA/Farr	Alaska Aviation System Plan, Phase I	State	2 years 6/83
R. Miller/ The Boeing Company	Alternate Transportation Modals	State	2 years 6/83
R. Miller J. Moody	Pulse Light Approach Slope Indicator (PLASI)	State	2 years 6/82
R. Miller D. Ross	Screw Pile Foundation Supports	State	2 years 6/83
R. Miller/ U.S. Maritime Administration Arctec, Inc.	Ice Breaker Trafficability Studies, Phase IV	State	1 year 6/82
R. Miller B. Allison	Aircraft Hydroplaning Prevention	State	3 years 6/83
R. Miller R. Snell	LORAN-C Flight Navigation Demonstration	State	1 year 3/83
R. Miller	Automated Weather Reporting Demonstration	State	2 years 6/83

RESEARCH ABSTRACTS

HIGHWAY RESEARCH PROGRAM

Highway Life Cycle Costing - Recent developments in the field of highway management have been directed toward the evaluation of total "Life Cycle" costs. This approach utilizes new computerized design techniques to assess the serviceability and longevity of various construction and maintenance alternatives. Construction, maintenance, and those user costs functionally related to pavement quality are then combined into a complete life cycle analysis. The overall effect of life cycle costing is to minimize the total construction, maintenance, and user expenditures, thereby providing a net savings to the people of the state. The results of this study by consultant Woodward Clyde will be published in July 1982.

Stabilized Soils Study - Various soil additives are being evaluated for reducing thaw weakening in silty gravel roadway bases and subbase materials and for bonding of organic sands and silts. If durable mixes can be developed, frost-susceptible silty gravels and even organic sandy silts could be used with stabilization chemicals in place of the clean sands and gravels normally required in highway and airfield pavement structures.

For areas of Alaska where "clean" materials are not available, major savings in construction costs should result from this study.

Resilient Soil Properties Study - This study is to determine the resilient modulus values of a full range of Alaskan highway construction materials and to identify and quantify the factors controlling their resilient behavior. A number of existing pavements and recent pavement designs are being evaluated to determine condition and performance potential. A new testing system is being installed, and operators are being trained to perform modulus tests that will be used to analyze the performance of Alaska's roadway pavement structures, which will improve future pavement design methods.

Snow and Ice Control Study - In the Maintenance Section of the Department approximately $10,000,000 is spent annually on snow and ice control on pavements. This expense is only to keep the roads open and safe for the traveling public and adds nothing to the overall improvements of the system. Since this cost represents approximately 20% of the total maintenance budget, significant savings can be realized by establishing improved and more cost-effective methods for controlling snow and ice problems. This study is investigating various aspects of snow and ice control to develop new techniques and policies. Specific projects authorized under this funding program include snow fence studies at Thompson Pass, sand-ice friction evaluation studies, benefit of chip seals for increased traction, and culvert icing control work.

Permafrost Culvert Study - Culvert installations in permafrost areas present various problems resulting in excessive long-term maintenance costs. Progressive warming of soils beneath the culverts can cause localized thawing, which eventually results in the culverts settling below the surrounding ground and requiring expensive replacement. In other cases, culverts can act as air circulation and cooling ducts, resulting in frost heaves at the culvert sites. The presence of permafrost around culverts also leads to early ice blockage where wintertime water flows must be carried.

Engineering Computer Software - This project provided computer terminals and plotting hardware for all three regions of the DOTPF to enable the engineering staff to have access to state-of-the-art computer programs. The Washington State Department of Transportation earthwork programs have been transferred onto the Boeing Computer System, which can be accessed by the DOTPF terminals. Several training sessions have been conducted to familiarize the engineering staff with these programs.

Pavement Thermal Study - The purpose of this study is to quantify the effects of pavement color and texture on average surface temperatures of roadway and airfield pavements located on permafrost. This is accomplished through the use of instrumented field test sections located on Peger Road in Fairbanks, and at Deadhorse, Alaska. White and yellow painted sections are used in this study along with chip seals of white, regular, and dark rock.

Roadway Strength Inventory - A Falling Weight Deflectometer (FWD) has been purchased to be used to inventory the structural strength of Alaskan highways. The FWD simulates the load imposed on the roadway by a moving truck by dropping a weight onto the surface with a force of 9,000 pounds. The deflection or bending of the roadway is measured and reported in much the same manner as the well-known Benkelman Beam technique.

Under this study, deflection data will be collected on an inventory basis which will allow estimation of pavement life, overlay thicknesses to be determined, and load restrictions to be placed.

Frost Heave Test Development - Funds provided under this study are being used to develop new types of frost heave laboratory test cells that will permit materials engineers to test various soils and pavement layer materials under conditions closely duplicating actual field exposure. These conditions will include the ability to cyclically freeze and thaw the samples, vary the vertical loads and lateral pressures, and duplicate different conditions of water availability and freezing rate. The test program will permit strength testing of the samples during or immediately after thawing.

Low Temperature Thermal Cracking Studies - This study is examining the mechanics and morphology of major transverse thermal cracks that form on Alaskan roads. A field examination of Interior Alaskan cracks will be complimented by laboratory investigations into the thermal expansion coefficients of highway construction materials. A primary objective of this research is to form an understanding of the basic physical nature of transverse thermal cracking. Potential solutions to this pavement problem will be evaluated based on project findings.

Thermal Analysis Computer Modeling - Designers are continuously concerned with degredation of permafrost under roadways, airports, and buildings. However, they generally have only rules of thumb and experience on which to base thaw depths. Computer models exist that predict ground temperatures over long periods of time and allow engineers to compare the long-range effects of various design alternatives on the thermal origin of permafrost. The object of this project is to select and verify the most appropriate computerized thermal analysis model for the Department of Transportation and Public Facilities. Report No. AK-RD-82-22, "A Preliminary Evaluation of Numerical Models Suitable for Thermal Analysis of Roadways and Airstrips," discusses computer modeling; other work is still in progress.

Solar-Assisted Culvert Thawing Devices - The objective of this project is to design, assemble, install, and monitor solar-assisted culvert thawing devices that would require minimal operating and maintenance expenses and be built using commercially available components. Two systems currently in the demonstration phase use a solar panel to heat an antifreeze solution circulated through the culvert. Report No. AK-RD-82-10, "Solar-Assisted Culvert Thawing Device," describes model one of this demonstration. A second system utilizing a linear parabolic reflector instead of a flat plate collector is presently being studied. Preliminary results indicate that in certain locations these solar assisted culvert thawing devices can result in considerable cost savings by eliminating repeated culvert thawing by maintenance crews.

Prethawing of Permafrost by Surface Modifications - Repair of roadways having unstable foundations is both a major maintenance item within the Department of Transportation and Public Facilities and a major headache and hazard to the motorist. Experience from old roadways and from roadway test sections, reveals that thermally stable embankments can be constructed over thaw unstable soils if a sufficiently thick layer of thawed soil overlies the permafrost. This thawed zone, however, should be developed either before or during the construction phase, not after.

This study is investigating the utilization of solar radiation and the preparation of the ground surface to absorb as much energy as possible as a means of achieving a deeper thaw zone. This entails the removal of the naturally occurring vegetative and organic ground surface covering, and the application of six different surface treatments to accelerate the net heat input into the ground during the summer months. The study will determine what surface modifications and times are needed to permit adequate thawing for construction applications.

Field Evaluation Site for Ground Ice Detection - Experience with permafrost and ground ice detection programs has demonstrated the need for a permanent evaluation site of known ground truth. A site containing a single subsurface ice mass of known size, shape, and depth was constructed during the winter of 1980-81. A mass of ice approximately 26 inches wide, 10 feet thick, and 120 feet long, and buried 3-1/2 feet deep was constructed in an area of nearly homogeneous frozen silt near Fairbanks.

This field site is now being used to evaluate various geophysical means for detecting subsurface ice from surface measurements. Electrical resistivity measurements, ground penetrating radar surveys, micro-gravity profiles, and other survey techniques are being conducted periodically at the site to test resolution dependence on seasonal temperature and moisture variations. An interim report, Report No. FHWA-AK-RD-82-13, "Field Evaluation Site for Ground Ice Detection," is currently obtainable. A final report will be available in October 1982.

Fish Passage Through Drainage Structures - This major FHWA funded project, which received approval in late April 1982, is a three-year study of culvert flow conditions on major highways in the Interior. It includes field investigations of culverts and a review of the literature on the swimming ability of fish, timing of migrations, and other biological factors affecting the ability of various fish species to pass through culverts. It also includes an evaluation of culvert baffles that have been used to aid fish passage.

This project assesses current knowledge about fish passage through drainage structures and give recommendations for additional field studies that might be needed to answer remaining questions. The costs involved in the current work can be justified if the number of bridges to be built (in place of culverts) is reduced by just one. At least 13 bridges are currently scheduled to be constructed on the Dalton Highway alone during the next two years at a cost of over $5 million. Another eleven bridges also are being considered on that highway for fish passage reasons. These bridges will cost over $4 million at today's prices.

Aspects of Streamflow with Regard to Fish Passage - Fish passage through drainage structures has traditionally been viewed in terms of maximum velocities that fish can maintain through given culvert lengths during the mean annual flood. Little work has been done to evaluate fish passage in terms of waiting time needed for a flow peak to subside and effect of this wait on productivity.

This project brings together available data on streamflow and uses predictive modeling techniques to establish statistical probability of flow peaks and duration thereof. The project includes a literature review regarding biological adaptation to waiting periods during spawning runs. Results will include a recommended methodology for establishing fish passage criteria.

Correlating Dynamic Deflections with Pavement Performance - The purpose of this study is to conduct comparative performance evaluations between the Road Rater and Falling Weight Deflectometer pavement testing devices for routine pavement inventory use in Alaska. The ability of each instrument to characterize observed pavement condition and to function properly throughout the project's duration will be addressed.

Evaluation of Air Duct Ground Stabilization System - A design manual is being prepared for using air ducts to stabilize thaw-sensitive ground. Coefficients of friction required stack heights, heat transfer rates, and effects of bends will be determined. All procedures will be compared to the existing air duct installation near Fairbanks.

Geophysical Methods for Detecting Permafrost and Ground Ice - Permafrost can cause substantial problems in the design, construction, and operation of roads, airfields, and buildings. Present foundation investigations in areas of suspected permafrost rely almost entirely on soil borings to determine the nature of the subsurface soils. While drilling does give excellent subsurface information, it can fail to detect a changing soil condition only a short distance from the selected boring site. Other investigative techniques are needed to provide a lateral view of the soil condition in a specific area to supplement information gained by drilling.

Several geophysical techniques have demonstrated the ability to detect and delineate permafrost and massive ground ice in certain soil types. Electrical resistivity measurements have proved useful in the identification of subsurface trends and are now being incorporated into state runway, roadway, and material site investigations --particularly remote sites where borehole information is difficult and expensive to obtain. Over ten surveys have been conducted during the past two years at sites under study by state geologists. Efforts are being sought to broaden this program into the detection of general subsurface features and to continue the review of geophysical instruments as they become available. A report on the application of soil resistivity surveys in foundation and material investigations by Department of Transportation and Public Facilities will be available October 1982.

Permafrost Research Site Monitoring - Various design features aimed at reducing permafrost-related roadway problems have been incorporated into new roadway construction projects. Following construction, temperature monitoring systems are installed and settlement and movement references established. Continuous air temperature recordings, monthly temperature measurements, and annual thaw and settlement surveys are used to measure long-term benefits of these design features. Studies in this area began in 1969 with construction of an insulated roadway near Chitna and have been progressively expanded to include long-term monitoring at six experimental roadway sites throughout the state. These studies are currently continuing.

Applications of Engineering Fabrics in Alaska - This study is evaluating the successes and failures of all Alaskan engineering fabric installations designed to act as filter layers or roadway fill reinforcement layers, and will provide design guidelines for future projects that will improve their performance.

Ice Forces on Northern River Bridges - This study provides data on actual ice forces for thick river ice conditions, and uses these data to recommend modifications to current code requirements for ice forces on river crossing structures. The site of this work is the Yukon River Bridge on the Dalton Highway where various load cell types have been installed on Pier #5 to measure ice forces during the spring break-up period. This research work is being performed by the U.S. Army Cold Regions Research and Engineering Laboratory at Hanover, New Hampshire.

Mechanistic Design Methods for Alaskan Pavements - The purpose of this study is to examine state-of-the-art methods for evaluating the structural designs of asphalt concrete pavements. Selected procedures will be made available to the Alaskan pavement engineer through a "user's manual" section in the summary report, and installation of selected programs on a computer system will be made accessible throughout the state.

Portable Powered Probe for Permafrost - To fulfill the need for a lightweight probe system to determine the depth to permafrost, all available electric impact hammers and hammer drills were reviewed and evaluated for suitability in driving and retrieving steel probe rods. A series of probe rods and rod tips of different

designs were fabricated for testing. The system determined most favorable is based on a 1/2-inch electric impact drill, driving 1/2-inch segmented rods with an enlarged 5/8-inch bullet nose tip. The rotation of the rods is important for ease of penetration and retrieval of the rods.

Rubberized Asphalt for Roadway Ice Control - This project is evaluating test sections of asphalt pavements constructed with 3% to 4% of roughly 1/8-inch sized ground rubber particles included in the paving mixes. The purpose of this study is to determine the benefits of this product in reducing surface ice formation and increasing tire friction in winter. Test sections totalling approximately 2.5 miles have been constructed in both Fairbanks and Anchorage and evaluated for durability and skid reduction. Fairbanks data, the most comprehensive, indicate an average 25% reduction in icy road stopping distances as a result of this test material.

Soil Stabilization for Remote Area Roads - Literature reviews were made to assist in determining the most suitable soil stabilization methods. Soil surveys were performed in gravel-deficient areas of Alaska scheduled for future transportation projects to determine typical soil properties and to obtain samples for laboratory evaluations of the benefits of different stabilization treatments. The benefits of various emulsified asphalts and cement were measured by extensive laboratory testing. The outcome of this study indicates that favorable results can be attained with some sandy soils while others are more resistant to beneficial treatments.

Optimum Sand Specifications for Roadway Ice Control - Expenditures for roadways and traction improvement on icy pavements approach $1 million annually in Alaska.

Studies of comparative friction levels attained by different sand gradations and angularities and also coal ash were performed in Fairbanks during 1980 and 1981. Various materials were evaluated by field tests on clear ice and on packed snow using a "Tapley" meter-equipped sedan. Laboratory cold-room testing with a "British Pendulum" friction test device was also used to evaluate comparative friction levels of the different materials. Freezer tests of sands with different anti-freeze agents were made to evaluate stockpile handling properties at subfreezing temperatures.

Fractured sand particles were found to be much more beneficial than rounded particles. Testing was also done to evaluate the relationships between sand particle sizes and damage to windshields. Results of these studies of roadway sand specifications are in the publication process.

Reliability of Alaskan Pavement Rating Procedure - This study is evaluating the Alaskan pavement inventory rating method. The repeatability in measuring various distress features, as well as minimum required sampling densities, is being determined. The work involves a statistical study of data aquisition and significance levels associated with the description of pavement performance on paved Alaskan roadways. Sections of highway are being rated by teams of Alaska DOTPF personnel, and studies on the repeatability of the ratings performed. A number of sections are being rated by continuous measurements and an evaluation of these data used to determine if a lower frequency of observation would be possible.

The objectives of this study are to establish the range of variability that might be expected when a paved roadway is performance rated and to determine the minimum sampling frequencies necessary to produce a reliable pavement rating.

Evaluation of Road Rater Test Methods - The purpose of this study is to provide an operational evaluation of the Road Rater Model 400A by defining: 1) load/frequency operating mode that provides the best correlations to Benkelman Beam deflections, 2) pavement temperature effects on Road Rater deflections, and 3) proper sampling frequencies. Objectives of this project include the development of a standardized test method for use of the Road Rater in Alaskan pavement design.

Economic Aspects of High Speed Unpaved Roads - The costs of constructing and maintaining gravel roads with dust control procedures as utilized in the Yukon Territory are being compared in this study with the costs of constructing and maintaining paved roads in permafrost areas between Fairbanks and the U.S./Canada border.

Design Guide for Pavements over Permafrost - A design guide manual to include all aspects of permafrost engineering related to roadways is essential to bridge the gap between the latest research work and the previously used procedures. This manual will update the existing design principles and will primarily provide background information to assist the designer of roadways constructed over permafrost. The manual has been compiled and currently is in the review process.

Design Manual for Roadways over Muskeg - This project involved compiling available literature and field data analysis to serve as a guide for roadway design over muskeg terrain. A manual has been prepared to summarize the necessary information and to formulate a systematic design approach. The latest soil reinforcement and the use of soil-fabric aggregate systems were analyzed in light of all other available methods and their applications evaluated. This manual is in the publication and review process.

Stress Monitoring of New Gastineau Channel Bridge - A new and innovative design for a prestressed segmental concrete bridge structure was constructed across the Gastineau Channel at Juneau during 1980 and 1981. The strain and deflection history of the cantilever and anchor spans were measured and compared with the load history and the theoretical predictions of these same strains and deflection. Particular emphasis is placed on the monitoring of creep. The purpose of this research is to monitor the structural behavior of the new bridge so that it can serve as a full-scale model to provide information for advancing the state-of-the-art of designing and constructing segmental structures.

Remote Monitoring of Springtime Thaw Depths - During the spring, most of the state roads experience thaw that results in a saturated base or subbase layer which is unable to provide structural support. Spring load restrictions are therefore imposed to protect the highway surface integrity until the embankment can regain its structural strength. It has been demonstrated that thaw depth can be directly correlated with the roadway deflection, and it is evident that accurate and inexpensive methods of determining the load-bearing status of a given roadway are needed. In this study, methods of remotely monitoring the depth of the freeze/-thaw boundary in a reliable manner are being sought. Several devices were installed in the Fairbanks area in April 1982 and are currently being evaluated. Radio telemetry of data from these devices will be attempted in the spring of 1983.

4th International Conference on Permafrost - Federal funding is being provided to the Geophysical Institute of the University of Alaska for use in organizing and hosting the 4th International Conference on Permafrost to be held in Fairbanks in July 1983.

Asphalt Surface Treatment (AST) Design - A recently completed study, Report No. AK-RD-82-9, "Performance of Bituminous Surface Treatments in Alaska," demonstrated that climatic conditions, particle size and shape, and construction techniques have a significant impact on the probability of successful construction of AST pavements.

The objective of this study is to provide the necessary information to rationally design an AST by determining the "local factors" in the design procedure developed by noted authority Norman McLeod, as described in "A General Method of Design for Seal Coats and Surface Treatments." This "local factor" will adjust the aggregate and asphalt cement spread rates to insure proper embedment of aggregate and aggregate retention. This study will also provide information to objectively establish specifications controlling construction and minimum climatic conditions.

Bridge Construction on Permafrost - In 1965, three bridges were constructed and founded on permafrost near Fairbanks. Instrumentation was installed to permit long-term temperature monitoring and elevation surveys to be made for several years to measure long-term movements. The purpose of this project is to obtain new temperature and movement data after 17 years of service. The report will analyze the long-term performance of these structures and provide recommendations for use on new designs for similar conditions.

Use of Preheated Maintenance Sand for Skid Control - Maintenance crews have found that the application of cold sand or rock chips is inadequate for icy road skid control because the sand and chips are blown off the roadway surface shortly after placement. If these materials could be bonded to the surface they would provide increased traction and safety. It may be possible to achieve greater bonding by heating the sand so that it will melt into the ice and refreeze, providing a sandpaper-like surface.

The objective of this study is to explore the benefits of preheating maintenance sand. The study will include both an analysis of the sand application method and an economic analysis. Several methods of heating the sand are being investigated to determine the best method.

Highway Thaw/Settlement Control - There are a number of highway routes within the Interior of Alaska that suffer continually from thaw and settlement problems. These areas require considerable maintenance effort annually and at times can become a safety hazard to the traveling public due to the rapid differential settlements that occur during the thawing season.

The objective of this study is to determine the feasibility and effectiveness of reducing thaw and settlement by reflection of solar energy from the roadway surface. This will be accomplished through periodic applications of white paint to the roadway in selected locations followed by accurate settlement surveys on a series of painted and unpainted problem areas.

Evaluation of AC-1.75 Asphalt - Thermal cracking damage is occurring on most Alaskan pavements. In order to minimize this problem, design practice usually calls for use of very soft asphalt materials. At the present time AC-2.5 is the softest grade of asphalt cement available for use on the state's highways. Although present materials provide generally good construction and performance characteristics, none have successfully prevented thermal cracking. In an attempt to alleviate this problem, an experimental road section utilizing specially produced AC-1.75 asphalt will be placed near Fairbanks. This research will evaluate overall performance of the AC-1.75 pavement by comparing it with the project's non-experimental AC-2.5 sections. The results of this research will determine the feasibility of AC-1.75 use in Alaska.

Decision Criteria for Seal Coating - The purpose of this study is to develop a decision policy to determine when a seal coat should be applied for purposes of extending the life of an asphalt pavement. Inventory methods will be developed and tested to provide information necessary to allow acceptable budgetary lead time.

The selection of the seal type depends upon the defect being corrected, availability of materials, equipment, and local climatic conditions. The selection process will require a field assessment of these defects, and a specialized roadway inventory method must be developed that can eventually be merged with current inventory.

Passive Solar Alaskan School - The Passive Solar Alaskan School Project, jointly funded by the State of Alaska and the U.S. Department of Energy, seeks to develop cost effective design criteria for integrating solar energy collection features into Alaskan public buildings. Phase I of this project concentrated on the development of a unit school building which would receive 45% of the space heating requirement and a similar portion of its lighting energy by collection of solar energy. Refer to Report No. AK-RD-81-10, "Passive Solar Alaskan School." In Phases II and III, which are now underway, the unit building concept is thematically repeated in a larger and more complex building--the Two Rivers School. Located approximately 20 miles northeast of Fairbanks, this school is scheduled for completion by July 1982. In addition to south facing windows and vertical overhang shading, one room of the school will be equipped with a thermal shutter system which is automatically controllable by internal lighting levels and temperature. Verification of design calculations as well as an economic evaluation of cost effectiveness will be made following one full year of energy usage monitoring. "Two Rivers Passive Solar Design Analysis," Report No. AK-RD-82-18, an analysis of the school's passive solar design, is currently available.

Thermal Performance Standards for State Buildings - The DOTPF has adopted the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Thermal Performance Standard (Energy Conservation in New Building Design) as the minimum energy efficiency level which the State will accept in new building construction. Recognizing, however that the ASHRAE standard was developed for a temperate climate, the Alaska statutes require the development of a modified standard more suited to high latitudes. The Research section has undertaken the second phase of this standards development during the past year. Primary emphasis has been placed on the evaluation of the economic implications of life cycle cost for frame construction using different levels of thermal stringency in the envelope, mechanical, and electrical systems. Phase II will culminate with the publication of a Phase II report and a skeletal standard for Alaska. The Phase I report, released in June 1981, is also available as Report No. AK-RD-81-19, "A Thermal Performance Design Optimization Study for Small Alaska Rural Schools."

Buildings Energy Conservation Studies - Under this heading are listed several individual projects aimed at reducing state expenditures for energy required in new and existing buildings. The thrust of this work is intended to contribute to the overall reduction of maintenance and operation costs of state buildings which are rapidly increasing as new capital projects are completed.

The following six entries are part of a comprehensive project.

1) Thermal Load Simulation for Small Buildings (F-LOAD) F-LOAD is an interactive computer program that calculates the heating load of residential and light commercial/institutional buildings. This program allows the incorporation of passive solar systems for heating as well as conventional heating systems. An optional economics section computes the life cycle cost of heating for the structure. The program serves as a quick and useful reference tool for comparison of heating loads for various design options, such as:

- varied insulation thicknesses in walls, ceilings, and floors;
- varied air change rates;
- building orientation;
- building shape and size;
- fuel type; and
- various passive solar energy features.

The F-LOAD program has been made available to personnel working for DOTPF. Workshops have been conducted in Anchorage, Fairbanks, and Juneau for General Design and Construction, and Planning and Programming personnel to introduce them to the various uses of the program and give them hands-on experience in its operation.

2) Air-Vapor Barrier - Air-vapor barriers as used in light construction are a subject of increasing importance in Alaska. Each year a significant amount of state money is spent to repair damage to buildings and their interior and exterior finishes caused by air-vapor migration. Improper air-vapor barrier installation also results in high energy costs due to increased air infiltration.

In an effort to increase understanding about the need for and use of air-vapor barriers, the Research Section has received permission from the Saskatchewan Research Council to reproduce and distribute their publication entitled "Air Vapour Barriers." This publication, probably the most complete reference available on air-vapor barriers in cold climates, is now available through the Research Section.

3) Insulation Shape Factors - When calculating the heat loss from a building envelope it is usually assumed that a steady state one dimensional heat transfer analysis is applicable. However, with the presently recommended construction methods, wall thicknesses have increased and below grade insulation techniques have developed to the point where that assumption may no longer be appropriate. This project proposes that a two dimensional heat transfer analysis be performed to develop shape factors for fenistration components and below grade insulation techniques of a "super insulated" structure. This will be presented in graphical form from which a "shape factor" for a specific design can be determined and the heat loss calculated.

4) Public Facilities Design Standards Review - The Department of Transportation and Public Facilities Standards and Technical Services is currently developing materials, design, and construction standards and specifications to be used by architectural and engineering firms for designing public facilities. This project provides for a DOTPF Research Section review of those standards and specifications prior to publication so that the results of presently completed research can be implemented into the routine operations of the department. This review also aids the Research Section in identifying those areas regarding specifications and standards where further research is needed.

5) Furnace Efficiency - There are many devices on the market today that claim to increase the efficiency of an existing oil-fired furnace/boiler. Very little independent testing has been done on such devices; consequently, the manufacturer's claims are all that is available to the consumer. By request of the DOTPF Interior Region Building Maintenance Section, this project will examine the effectiveness of a combustion air ionizer. The project will also perform rigorous efficiency testing of an unaltered furnace/boiler to provide the department with good baseline furnace efficiency data.

6) Indoor Air Quality - Two major projects regarding indoor air pollution were identified as a result of investigations conducted. Both of these projects were given priority by the DOTPF Research Board in April 1982. The concerns of these two projects are the impact of building ventilation rate on indoor air quality and the effect of activated carbon filters on recycled air. The goal of this work is to determine the extent to which heating costs for makeup air can be reduced while still maintaining acceptable air quality in public buildings.

Remote Facilities Monitoring - The State of Alaska operates a variety of remote facilities that are not regularly attended by skilled technicians. Many utility failures within these facilities could be detected by monitoring systems and preventive action taken before catastrophic failures occur. Savings in fuel for heating and electric energy might also result from prompt identification of inefficient operating conditions or faulty equipment.

Report No. AK-RD-82-11, "Maintenance Monitoring for Remote Public Facilities--A Feasibility Study," identifies dominant maintenance problems in remote facilities, means by which they can be detected, the level of monitoring appropriate to various facilities, and a strategy for implementation. Recommendations for the implementation of monitoring systems are described in the following paragraphs.

1) Rural Electric Power Quality - Many operational problems associated with electrical equipment installed in rural facilities originate from voltage and frequency excursions in the power grid to which the facility is connected, or in the on-site power plant in the case of a self-generating facility. These disturbances range from actual power outages to voltage sags and surges, voltage impulses, and frequency deviations. The objective of this project is to determine the extent to which electric power disturbances affect the physical plants of rural state-owned and operated facilities and to recommend techniques and hardware to protect the facilities from poor power quality. Completion of the final report is expected July 1983.

2) Freeze-Up Alarms - Research Section personnel are in the process of designing a freeze-up alarm system for use in alerting maintenance personnel to abnormally low temperatures within state facilities. These units will be installed within existing structures where there has been a history of utility freeze-ups and in facilities where freeze-up would result in a substantial loss in terms of both the use and repair of that facility. The design of a prototype system will be completed in summer 1982 and field tested this coming winter.

3) Monitoring of Heat Generation Equipment - It may be possible to more accurately control the fuel usage of rural facilities by monitoring various parameters of the heat generation and delivery systems. During FY 82 some preliminary work was done toward the development of a monitoring system in support of the thermal performance standards project. It is anticipated that this system will be implemented and tested during FY 83.

Fuel Cell Evaluation - Because of the high energy-conversion efficiency of fuel cells, they offer a potentially attractive alternative to the diesel-electric generators presently used in rural Alaska. The objective of this project is to evaluate the feasibility of using a methanol-fueled phosphoric acid fuel cell (PAFC) as an electric power source to replace the diesel-electric generators now used in many rural Alaskan state buildings. A preliminary literature search has found limited information on the use of fuel cells in this context although the literature does suggest that such applications might significantly save money in the maintenance and operations of buildings, both state and private.

The evaluation will address the safety, operation, reliability, maintenance and cost aspects of the fuel cell power plant that are generic to the Alaskan environment and to preliminarily assess feasibility. Also, an experimental program for further study of the more significant problem areas will be developed for a continuing phase if preliminary assessments look promising.

Gas-Sorptive Properties of Zeolite Mordenite - This project was first conceived as an investigation of properties of the Alaskan Zeolite mineral to determine if Zeolites could be used as a storage medium of fuel grade hydrogen. The results have shown that, while not fully conclusive, hydrogen storage is probably not an economical use of Zeolites. However, as a spin-off result, Alaskan Zeolite was found to have heat-of-absorption properties which have significant potential for the long-term storage of solar heat. As a result, the University of Alaska has expanded its research into Zeolites with support from federal and other state agencies. This study also has shown that Alaskan Zeolites might be of use as molecular sives for the production of hydrogen, oxygen, and/or methanol from Alaskan coal.

Small-Scale Heat Recovery - With the escalation of fuel costs, many people are turning to tighter, better insulated buildings as a means of achieving energy conservation. This is especially true in northern climates, where heating seasons are long and severe. Installing efficient, well-sealed vapor barriers, weather stripping, and caulking around doors and windows reduces cold air infiltration but can lead to damaging moisture buildup, as well as unpleasant and even unhealthy accumulations of odors and gases. To provide the necessary ventilation air to maintain interior air quality while holding down energy costs, air-to-air heat

exchangers have been proposed for residential and other simple structures normally not served by an active or forced ventilation system.

The operating principles of several air-to-air heat exchangers suited for small scale use were investigated and their individual advantages and disadvantages considered. A test program was conducted to evaluate the performance of several heat exchanger units of both commercial and "home built" design and construction. The results of the investigations and testing and a critique of the units' designs are presented in Report No. AK-RD-82-23, "Air-to-Air Heat Recovery Devices for Small Buildings."

Use of Sun Spaces in Alaska - Sun spaces, incorporated into the design of new buildings or added to existing buildings as a retrofit, are gaining popularity as a technique to capture useful amounts of solar energy in northern climates. A problem with these techniques for designers in Alaska is the lack of experience with this form of architecture in high latitudes and an inadequate data base on which to evaluate a specific application.

To help alleviate this situation, the Research Section has compiled the best available theoretical data with experimental results to form a design manual. This manual covers both the technical and economic parameters associated with design, construction, and performance of sun spaces at Alaskan latitudes, with primary emphasis placed on applications on small rural facilities. Refer to Report No. AK-RD-82-25, "Use of Sun Spaces in Alaska."

Roofing Design and Materials Investigation - Maintaining the integrity of roofs is a major portion of the upkeep cost for state facilities. Investigation by the Research Section has shown that new knowledge is not required to construct a quality roof. However, if improperly handled, any combination of design, materials and/or construction procedures can contribute to roof system failures. The objective of this project is to develop standards and specifications for roofing designs, materials, and construction techniques addressing varying climatic zones and geographic areas. Additionally, a maintenance checklist and inspection schedule for each generic roofing system will be recommended. This information will be presented in a set of building design standards being developed and assembled by Department of Transportation and Public Facilities Standards and Technical Services for use by Public Facilities architectural and engineering consultants.

Digital Telemetry (Meteor Burst) - The reflection of radio signals from ionized meteor trails allows transmission of low data rate digital messages over distances of up to 1200 miles. The reflecting medium is short-lived, but computer technology permits the transmission of appreciable amounts of information in a "burst" lasting only a few tenths of a second. A federally-funded meteor burst network within Alaska has been in operation for several years. Its primary function has been the retrieval of scientific and meteorological information from unmanned sites.

This demonstration project evaluates the latest available equipment and familiarizes state officials with its capabilities and limitations. Operational data from rural state facilities, remote aviation weather monitoring, and emergency statewide communications are a few examples of how this technique could be utilized. An interim report, Report No. AK-RD-82-4, "Meteor Burst Demonstration Project," is currently available. The final report will be issued during October 1983 following completion of the demonstration.

Vehicle Emission Effects on Air Quality - The Department of Transportation and Public Facilities is supporting the Department of Environmental Conservation with funding of a major investigation of light duty vehicle emissions under cold weather conditions. Cold Regions Research and Engineering Laboratory has contracted to carry out the work which included over 150 vehicle tests during the 1981-82 winter season. Environmental Protection Agency (EPA) test methods, incorporating the constant volume sampler from a mobile emission test facility donated by EPA, were used throughout.

The goals of the project are to develop an Alaskan driving cycle and use the vehicle emissions data to determine the impact of vehicle inspection and maintenance program, cold starts, and other cold weather factors which influence air quality in the Fairbanks region. Specifically being evaluated are the potential benefits of an inspection and maintenance program as a carbon monoxide control strategy. Prior to this project, no automotive emissions data had ever been collected in Alaska using EPA-approved testing methods.

Fire Protection in Bush Areas - The incidence of fire in bush Alaska is among the nation's highest. Traditional water sprinkler fire protection systems for bush area institutional buildings are expensive to install and maintain, especially in areas without utility water, which is a common occurrence in many locations. When

activated needlessly or to control a very minor fire, sprinkler systems can cause tremendous damage to buildings and their contents, especially during the winter months. Sprinklers are also vulnerable to freeze damage and other problems if not properly maintained, possibly leaving the structure damaged by water and/or unprotected.

This project demonstrated that an industrial Halon 1301 Gaseous Fire Suppression System can be modified for institutional/residential use as a viable alternative to the water sprinkler system. The system was installed in a Bethel, Alaska hostel for approximately the same price as a water system and has now undergone a year of monitoring. The system appears to offer the same level of protection as water with much lower maintenance. It does not risk structural damage and greatly reduces downtime should the system be employed as compared to the water sprinkler system. Refer to interim Report No. AK-RD-82-5, "Halon Fire Suppression System Demonstration for the Alaskan Bush."

Public Facilities Building Codes - Since the oil embargo of 1973 there has been an ever-increasing nation-wide emphasis on revision of building codes. Unfortunately, existing codes are not entirely suitable for the climatic extremes of Alaska. This project involves a review of relevant codes to identify and prioritize areas where new solutions are needed for state facilities. The reason for this is that much of our current code requirements evolved during a period when energy costs were low; thus implementing codes increased energy consumption was not considered a problem at that time. These changing economic priorities are most critical to cold regions.

Public Building Life Cycle Costing - As the cost of operating and maintaining buildings increases due to escalating energy and labor costs, the mathematical parameters used in arriving at the total life cycle cost become more critical. This project is evaluating the trade-offs between initial costs and continuing costs of state buildings. The goal of this project is to develop a set of economic parameters that best represent the least cost to the state when using least life cycle cost calculation methods.

Utility Freeze Protection - Power outages and equipment failures are common in rural areas. Replacement parts and the technical knowledge necessary for repair of downed equipment are not always readily available. The

time between the disruption of the utility service and a successful repair can result in further system damage from broken pipes due to freezing.

The utility freeze protection project has been developed to test the usefulness of phase-change salts in prolonging the time it takes a utilidor to drop to freezing temperatures after a power outage has occurred. This "time extension" could allow a qualified maintenance person time to arrive with parts to fix the problem before additional damage occurs to the utility system.

Testing has been completed on a utilidor section in the university's cold room facility. Water and sewer pipes were placed in the utilidor and tests were run both with and without the salts at cold room temperatures of $+10^{o}F$, $0^{o}F$, and $-10^{o}F$. The data from the tests are presently being placed on a computer and analyzed.

Gasohol and Alcohol as Vehicle Fuel - The use of gasohol as a vehicle fuel has gained popularity nationwide. Current research has identified problems associated with its use under cold conditions, but has not addressed those problems with field studies. This project demonstrated the use of gasohol throughout a year in Fairbanks to determine the feasibility in a cold climate. The results are available in the report entitled "Gasohol as a Vehicle Fuel in Sub-Arctic Climates," Report No. AK-RD-82-20.

TRANSPORTATION SYSTEMS RESEARCH PROGRAM

Noorvik Airport Lighting Demonstration - During the summer and fall of 1979 a demonstration project was conducted to identify and develop a highly reliable, low maintenance electric power supply system to serve as an appropriate alternative to the diesel-electric generator for powering runway lighting systems at rural Alaskan airports. The project used an organic Rankine cycle turbo-electric generator and a large battery bank as primary components. The major advantages of this system are its high reliability, minimal maintenance requirements, and relatively long life cycle (20 years). It was found that this generator also permitted the use of a simple waste heat recovery system to greatly enhance overall efficiency, plus a photovoltaic solar panel to maintain fully charged batteries during the summer months.

In early October 1980, an FAA-approved lighting system was installed at the Noorvik airport using village supplied electricity as the power source. In late March 1981 two Ormat organic Rankine cycle generators were installed. This project provided a demonstration for comparison of reliability and costs of both power sources, and was completed in April 1982. The system operated nearly unattended, demonstrating its effectiveness. Ormat Systems Inc. is the consultant performing this work.

Air Cushion Vehicle (ACV) Demonstration Project - An ACV demonstration project was conducted in Bethel, Alaska from January 1980 to October 1981. The project included the use of a six-passenger, high-speed, gasoline-powered vehicle and a diesel- powered, 60-ton payload hoverbarge propelled by wheels and paddle wheel system. The project included operation of both craft on a year-round basis, serving villages along the Kuskokwim River and traveling over water, land, ice, and snow. The small craft executed approximately 150, 20-mile trips as of June 30, 1981 while the hoverbarge made 12 trips, each approximately 180 miles in length during this same period. The small craft serves 3 villages while the hoverbarge serves 15 villages each month.

This project was initiated to test the feasibility of ACV use as an economically and environmentally acceptable year-round means of transporting freight and passengers in western Alaska. The project also stimulated interest in ACV use by the private sector, particularly within the oil and gas industry.

Air Cushion Vehicle (ACV) Environmental Impact Study - An environmental impact study on the effect of ACV's has provided a basis of information for the further use of these vehicles. This study was performed by the consulting firm LGL Alaska Research Associates Inc.

Paint Performance Testing - The Division of Maintenance and Operations presently utilizes traffic paint specifications that detail the composition of paint which will qualify under DOTPF bid specifications. It has been found, however, that these specifications do not always determine the durability of the paint. The purpose of this testing is to develop a bid procedure where the major criteria is the durability of the paint in order to reduce the cost of traffic painting. This work will be performed by Woodward-Clyde Consultants and is in progress.

Anchorage Traffic Computer System Improvements - The Anchorage traffic bowl area has nearly all traffic signal lights tied into a centralized computer system to control the flow of traffic. This system was completed approximately four years ago and has been operating successfully for about three years. During that time improvements to the existing system have been proposed, but before any changes on an area-wide basis are made, development and demonstration of the changes must be conducted to determine the benefit of each change. The objective of this project is to improve traffic flow within the Anchorage area to keep up with increased traffic. These changes will be completed by late summer 1982.

Utilization of Yukon River Bridge for Gas Pipeline Crossing - Pursuant to an agreement with the Pipeline Coordinator, Division of Pipeline Surveillance, the DOTPF contracted with consultant Peratrovich and Nottingham, Inc. to prepare criteria for the factors to be addressed by Northwest Alaskan Pipeline Company (NWA) in completing studies, including risk analysis, for using the Yukon River Bridge as their gas pipeline river crossing. Report No. AK-RD-81-17, "Use of Yukon River Bridge Risk Analysis Criteria Development," developed those criteria. Peratrovich and Nottingham, Inc. will also assist the state in determining the validity of the investigations recently performed by NWA.

Transportation Research Projects - This program includes three research projects as follows:

"Design Criteria for Driven Piles" is a review of existing driven pile technology by consultant Peratrovich and Nottingham, Inc. A design guide is being developed which can be applied directly to arctic or permafrost foundation installations.

"Corrosion Research and Recommendations" is an analysis of existing corrosion information and data in order to develop specific recommendations for future design applications and for winter road maintenance procedures. This project is being performed by consultant Peratrovich and Nottingham, Inc.

"Fairbanks Traffic System Research" is a development project being conducted by the Interior Region Design and Construction Traffic Section and involves changes to components of portions of the Fairbanks transportation system including purchase of traffic control hardware.

Alaska Aviation System Plan, Phase I - Phase I of the Alaska Aviation System Plan identifies the various significant issues affecting state-wide aviation in Alaska and the magnitude of the problems associated with each issue. Phase I recognizes the existing responsibilities of the DOTPF and other state and federal agencies, addresses the options available to the state toward each issue, and presents an analysis of the costs and other implications associated with each future potential course of action.

The final report for Phase I describes the range of alternative actions available to improve aviation in Alaska and implications associated with the implementation of each action. The focus of the report is upon the development of technical information and analyses that are necessary prerequisites to informed decision-making. Phase II of the study will focus on developing policy and detailed implementation plans for the preferred courses of action. The consultant for this work is TRA-Farr, Inc.

Alternative Transportation Modals - This demonstration utilizes a 160-passenger Boeing Jetfoil to study the capability of hydrofoil operation at 11 different ports in Southeast Alaska. The project will run for two periods: summer from mid-August to mid-September 1982 and winter from mid-January to mid-February 1983. Approximately 225 hours of ship time will be provided. Costs of operations and feasibility of the craft will be assessed during the demonstration. This work is being performed by The Boeing Company.

Pulse Light Approach Scope Indicator (PLASI) - The PLASI system furnishes a pilot with precise visual approach slope information to provide safe descent guidance. The PLASI device is also expected to have lower annual maintenance and operations costs than the standard Visual Approach Slope Indicator (VASI) system.

A PLASI device was installed at the gravel airstrip next to Lake Hood at the Anchorage International Airport in mid-April 1981 through mid-October 1981. The objective of this demonstration was to establish the economics, maintainability, and acceptability of the PLASI versus a VASI. The results of this test are encouraging. During a runway foundation failure problem at the Bethel Airport in January 1982, which rendered the standard slope approach indicator equipment inoperative, the PLASI equipment was installed on an emergency basis. This equipment allowed the continued use of the airport by commercial carriers.

Screw Pile Foundation Supports - A project is being conducted to determine whether screw piles can be placed by hand methods to adequate depths to resist vertical and horizontal loads imposed by small supported structures. The anticipated benefit of this project is the development of a low cost foundation system that can be placed by local labor in most of rural Alaska.

Icebreaker Trafficability Studies, Phase IV - This is a continuing contract with the U.S. Maritime Administration. The objectives of the project are to define environmental conditions that affect navigation along potential trade routes in the Bering and Chukchi Seas, to evalute ship performance in that environment, and to assess operational performance requirements for future commercial icebreaking ships operating along those trade routes.

Aircraft Hydroplaning Prevention - Aircraft accidents attributed to the hydroplaning phenomena are of major national concern, and the Federal Aviation Administration has embarked on a program to have at least one runway at each air carrier airport served by jet transports to either be grooved or have a porous friction course (PFC) surface. To date, there has not been adequate study of these preventive measures against hydroplaning in an arctic environment. This project will study these techniques and document the need for hydroplaning prevention measures, as well as estimate the effects in terms of additional user costs of runway design, construction and maintenance alternatives. Two different hydroplaning prevention techniques are presently being incorporated into the Kodiak Airport runway.

Long Range Navigation (LORAN-C) Flight Naviation Demonstration - The objective of this project is to present performance data collected in Alaska that will be applicable in the consideration of LORAN-C as a navigational aid for aircraft. This is a joint effort between the FAA and DOTPF to accomplish a technical and operational flight evaluation of LORAN-C. It also includes preparation of a detailed test plan to guide the collection and analysis of performance data, instrumentation of an aircraft for the planned flight test, flight tests according to the plan, reduction and analysis of the collected data, and preparation of a final report directed toward the use of LORAN-C as an aircraft navigational aid. The LORAN-C equipment is expected to arrive in Alaska in summer 1982.

Automated Weather Reporting Demonstration - An Automated Weather Observing System (AWOS), which will automatically acquire, process, and disseminate aviation weather observations, is currently being studied. The system information will include wind speed and direction, temperature, dew point, precipitation occurrence and quantity, altimeter setting, visibility, cloud height and ceiling, density, altitude, time, and airport identification. This project is being performed by the FAA under contract to the DOTPF. The AWOS equipment will be located at Valdez and Galena where manned weather observations will be compared with AWOS data to verify accuracy and pilot acceptance of the automated system.

SECTION 3
SPECIAL PROJECTS AND NEW PRODUCTS TESTING

OBJECTIVE

The Research Section responds to inquiries and requests regarding the testing of new products or techniques that could be of value to the state. These requests come from within the department, the legislature, other state agencies, and from the private sector. Some of these requests form the basis of continued research projects that might be funded through the normal budget request cycle, while others require a few hours or days of evaluative effort. Special projects that received funding this fiscal year are summarized in this section.

HIGHWAY RESEARCH PROGRAM

Reinforced Earth Slab Evaluation - A reinforced earth slab was used to reduce the stresses induced by a retaining wall on a concrete box culvert near Auke Bay in the Juneau area. This is the first time in the United States that a reinforced earth slab of this type has been used in this manner. Funding was provided to help instrument this slab so that the performance could be monitored. This project is described in Report No. AK-RD-82-19, "The Use of A Reinforced Earth Slab to Reduce Embankment Loads at Auke Bay, Alaska."

Chem-Crete Asphalt Additive - A commercial product known as Chem-Crete is being evaluated as a viscosity modifier for paving asphalts. A laboratory study will assess its ability to stabilize soft asphalt at elevated temperatures while not adversely affecting its overall aging characteristics and low temperature properties.

Laboratory tests are presently in progress with test mixtures of both AC-2.5 and AC-1.75 asphalt cements. A 1,000 foot test section of asphalt pavement between Canyon Creek and Shaw Creek will be laid utilizing Chem-Crete as an additive to field test the effectiveness of the product.

Fabric Reinforced Embankments/Soil Stabilization - Two products are currently being evaluated to determine their effectiveness in stabilizing soils. A private consultant has concluded an analysis on fabric materials that may

have application in spanning small settlement areas in highways. A test section will be installed during the 1982 winter and monitoring during 1983 will evaluate performance.

A second product, an expandable polyethylene grid, may have application in stabilizing sandy soils. If successful, this could have application on airports in the Arctic and along the western coast of Alaska where sources of gravel are in short supply or nonexistent.

Impulse Radar Evaluation - Portable radar devices are being developed that can penetrate many feet into the ground. An evaluation test of such a device was made to determine its effectiveness in locating frozen peat and ice lenses under existing or proposed highway and airports. The test was successful in that considerable information could be determined. However, at the present time, the data from the more portable, hand-held, resistivity measuring devices are easier to interpret.

Traffic Detector Loop Sealants - Traffic signals at intersections are often actuated by detector loop wires in slots cut into the pavement. Because of a high failure rate of the loop detector wires, a program of testing various sealants has been initiated. Five different sealants were installed on Muldoon Road in Anchorage and will be evaluated over a period of several years.

Highway Delineator Posts - The installation and replacement of highway delineator posts can be a major problem in winter conditions. One hundred posts of a new type were bought and installed to determine the ease of replacement during winter conditions. The results were mixed for this particular brand.

Paint Stripe Removal - A new type of paint burner device was purchased and will be demonstrated in various regions. This unit is designed to remove old traffic paint stripes efficiently and with minimal pavement damage.

Ceramic Insulation - A sample of a silicate glazed perlite insulation, reported by its manufacturer to exhibit an equivalent R-factor of 23.3 per inch when used as a building insulation, was tested to verify that claim. The insulation was also evaluated for permeability and flammability. Conductivity testing was performed using nonstandard methods, duplicating the test methods used by the manufacturer. Test results showed the R-value to be approximately 3.1 per inch. The material was also found to be totally fireproof, but highly hydroscopic and not an effective vapor barrier. Refer to Report No. AK-RD-82-24, "New Product Evaluation: Ceramic Insulation."

Autotherm Benefits Testing - A device for reducing fuel consumption and minimizing harmful emissions due to idling was installed on six DOTPF vehicles and evaluated during the winter of 1981-82. Results showed that the devices, which take heat from the engine via the coolant system to keep the passenger compartment warm, are only effective down to about 0°F. Only vehicles that are idled a good deal for passenger comfort would benefit from installation and use of an autotherm unit. See Report No. AK-RD-83-9, "Evaluation of Autotherm Energy Conservation System."

Utilidor Freeze-Up (Utility Freeze Protection) - Power outages and equipment failures are common in rural areas. Replacement parts and the technical knowledge necessary for repair of downed equipment are not always readily available. The time between the disruption of the utility service and a successful repair can result in further system damage from broken pipes due to freezing.

The utility freeze protection project has been developed to test the usefulness of phase-change salts in prolonging the time it takes a utilidor to drop to freezing temperatures after a power outage has occurred. This "time extension" could allow a qualified maintenance person time to arrive with parts to fix the problem before additional damage occurs to the utility system.

Testing has been completed on a utilidor section in the university's cold room facility. Water and sewer pipes were placed in the utilidor and tests were run both with and without the salts at cold room temperatures of +10°F, 0°F, and -10°F. The data from the tests are presently being placed on a computer and analyzed.

Solar Room Experimentation - To encourage use of solar energy, the U.S. Department of Energy established a marketable products contract with Solar Resources, Inc. Under the field testing objectives of the contract, Solar Resources, Inc. was able to provide their "Solar Room" product to agencies throughout the U.S. for experimental use in various climates.

The solar room consists of two layers of ultraviolet-inhibited polyethylene ("twin skin") supported over steel tube framing three feet on center. The twin skin is air inflated using a small squirrel cage fan with the inside layer supported by the steel framing and the outer layer supported by air.

The solar room is presently installed on a southern exposure against a double width trailer. Indoor and outdoor temperatures are monitored to evalute the use of the room under Fairbanks' climatic conditions. Some of the data from the solar room has already been used in the preparation of Report No. AK-RD-82-25, "Use of Sun Spaces in Alaska."

Insulated Shutters - The Research Section has constructed a large scale Guarded Hot Box conforming to ASTM C 236 specifications for use in testing thermal conduction characteristics of building components. Conduction measurements will be possible on items as large as 4 feet by 6 feet over a temperature differential of 100^{o}F. Evaluation of insulated window shutter systems, metal stud walls and specialty windows will be conducted using this facility. The calibration of instrumentation is expected to be complete by July 1982. Component testing may then begin and should continue on an as-needed basis. This equipment is jointly owned and operated by the DOTPF Research Section and the School of Engineering at the University of Alaska.

TRANSPORTATION SYSTEMS RESEARCH PROGRAM

Pulse Light Approach Scope Indicator (PLASI) - The PLASI system furnishes a pilot with precise visual approach slope information to provide safe descent guidance. The PLASI device is also expected to have lower annual maintenance and operations costs than the standard Visual Approach Slope Indicator (VASI) system.

A PLASI device was installed at the gravel airstrip next to Lake Hood at the Anchorage International Airport in mid-April 1981 through mid-October 1981. The objective of this demonstration was to establish the economics, maintainability, and acceptability of the PLASI versus a VASI. The results of this test are encouraging. During a runway foundation failure problem at the Bethel Airport in January 1982, which rendered the standard slope approach indicator equipment inoperative, the PLASI equipment was installed on an emergency basis. This equipment allowed the continued use of the airport by commercial carriers.

Screw Pile Foundation Supports - A project is being conducted to determine whether screw piles can be placed by hand methods to adequate depths to resist vertical and horizontal loads imposed by small supported structures. The anticipated benefit of this project is the development of a low cost foundation system that can be placed by local labor in most of rural Alaska.

Icebreaker Trafficability Studies, Phase IV - This is a continuing contract with the U.S. Maritime Administration. The objectives of the project are to define environmental conditions that affect navigation along potential trade routes in the Bering and Chukchi Seas, to evaluate ship performance in that environment, and to assess operational performance requirements for future commercial icebreaking ships operating along those trade routes.

SECTION 4
IMPLEMENTATION

OBJECTIVE

The end product of applied research and development is implementation into everyday use. Listed in this section are the results of research projects that have changed previous practices or made other positive contributions. Several projects have been highlighted in this section: the Falling Weight Deflectometer studies, which are giving valuable new information on pavement condition during spring breakup, as well as becoming a powerful design tool; soil resistivity surveying techniques, which are being used extensively in determining subsurface soil conditions under proposed airfields and highway alignments; the Noorvik Airport lighting demonstration, which tested a prototype remote power system being used for unattended, pilot controlled lighting of the runway, taxiway and beacon; and the solar assisted culvert thawing devices located near Fairbanks which are being developed to keep culverts free of ice using the sun's energy. Many other implemented projects and changes are equally important and are summarized herein.

HIGHWAY RESEARCH PROGRAM

Asphalt Pavement Design Specifications

A totally new method of pavement design has been developed and was adopted in March 1982 based on results of pavement performance research performed from 1978 to 1981. This new method permits use of thinner and more economical pavement structures in many areas, yet assures longer pavement life through more efficient design. These results are detailed in Report No. AK-RD-82-6, "Prediction of Roadway Strength from Soil Properties."

Rubberized Asphalt

A test section of Rubber-Asphalt pavement at the Peger-Van Horn intersection in Fairbanks has demonstrated that during the winter of 1981-82 the average stopping distance was reduced by 25%. Research Report No. AK-RD-82-17 entitled "Construction and Benefits of Rubber Modified Asphalt Pavements" describes this project.

Annual Highway Condition Surveys

Annual road condition surveys are performed and pavements needing repair are identified by means of a rating method developed by the Research Section. This information has been compiled annually by the Research Section since 1978. The purchase and use of a new Falling Weight Deflectometer (FWD) pavement strength testing device gives deflection data on a volume basis to:

1. set and remove load restrictions
2. provide input data for current pavement design procedures
3. point out probable problem areas due to weak pavement structure and
4. estimate remaining pavement life.

Resilient Modulus Testing

New resilient modulus soil and pavement test equipment has been acquired and is presently being used as a basis for recommending the most cost effective asphalt type for the College Road recycling project. This equipment will continue to be used for recommending other highway recycling projects in Alaska.

Performance of Bituminous Surface Treatments (BST) in Alaska

Performance evaluations of Bituminous Surface Treatments have resulted in significant modifications in the construction specifications and design techniques. These changes are documented in Report AK-RD-87-9, "Performance of Bituminous Surface Treatments in Alaska."

Engineering Computer Software

Engineering computer software packages have been installed on the Boeing Computer System that provide various earthwork computer techniques to engineers in all regions. A final report on this work will be available in the fall.

Pavement System Evaluation

The results of several recent projects, as well as prior work on frost susceptibility testing, have been used to develop a totally new method of roadway pavement design, termed the "Excess Fines" method. The Excess Fines method has now been adopted by the Alaska

Department of Transportation and Public Facilities. Because this method was developed based on the performance of 120 Alaskan Highway sections, it has already been tested extensively and proven superior to prior design methods. The Excess Fines method permits the use of slightly thinner pavement structures than under the previous design approach, and eliminates the need for the costly and ineffective R-value test. In addition, it emphasizes the use of field deflection testing, which results in more accurate and economical pavement structures. This work is covered in Report No. AK-RD-02-6, "Prediction of Roadway Strength from Soil Properties."

Air Duct Permafrost Stabilization Systems

A system using corrugated pipes designed to remove heat and refreeze thawed permafrost soils each winter by natural convective heat flow will be installed on the Alaska Highway near Northway in 1982. This installation, used to prevent roadway slope movements, was designed based on experimental installations near Fairbanks made in 1975. Work is continuing on this technique.

Portable Permafrost Probe System

Developed in early 1981, a permafrost probing system was successfully used for thaw depth probing beneath roadways and building foundations. Depths of 30 feet can be easily reached using only an 8 pound, 1/2-inch impact drill with threaded steel drive rods of a special design. The probe rods can be easily withdrawn by manual effort only.

Solar Energy for Highway Uses

A solar energy system was designed, constructed, and installed as an alternative energy source for powering flasher signals at a highway-railroad grade crossing in a remote area. The system is nearly maintenance-free, more cost effective than the system it replaced, and should be considered as a viable energy source at remote locations. As a result of this study, the Alaska Railroad has installed similar solar energy systems at three additional remote locations to furnish energy for signals at highway-railroad crossings and at three microwave repeater locations as a part of their communication system. Railroad personnel report satisfactory operation for all of the six additional installations. This study will result in an estimated $232,000 savings for the four highway-railroad crossings over the next 21 years. A report is in the process of being published.

ENERGY AND BUILDINGS RESEARCH PROGRAM

Automatic Window Shutter Systems

The use of direct gain, southern exposure glazing with an automatic controlled window shuttering system was demonstrated in the construction of a state funded school (Two Rivers Elementary School). Since the Two Rivers School solar features were first presented at the annual convention of the Alaska Chapter of the American Institute of Architects in November 1981, several other state schools now in the planning stages are incorporating similar systems in their designs.

Building Energy Analysis System

Public Facility Planners and Design Managers now have a program entitled "F-LOAD" available for their use on the University of Alaska Honeywell computer network which can be accessed by all regions of DOTPF. F-LOAD is an interactive program that calculates the heating load of residential or light commercial/institutional buildings. A unique feature of the program incorporates passive solar design analysis. This feature permits quick comparison of various designs to evaluate the potential energy efficiency of a new building at the specific location. By evaluating several alternative designs in the preliminary stages of design development, more energy conservative approaches can be identified and followed up throughout the entire design process.

Workshops were held for General Design and Construction and public facility planning employees in Anchorage, Fairbanks, and Juneau to give them hands-on experience on the use of the program. Manuals were distributed to all regions for future reference. Implementation of the use of this computer technique into routine operation can result in significant long-term energy savings and lower life cycle costs for the operation of state buildings.

TRANSPORTATION SYSTEMS RESEARCH PROGRAM

Anchorage Traffic Computer Improvements

This project produced a more efficient time response within the traffic control system for the Anchorage bowl, thereby reducing the delay time in several congested sectors of the system.

Utilization of the Yukon River Bridge for Gas Pipeline Crossing

The report developed for this project by consultant Peratrovich and Nottingham, Inc. established the risk analysis criteria for using the Dalton Highway Yukon River Bridge for the gas pipeline river crossing near Northwest Alaskan Pipeline Company. Northwest's response to these risk criteria is now being evaluted by the state in order to determine the future use of the bridge for supporting a gas pipeline. Refer to Report No. AK-RD-81-17, "Use of Yukon River Bridge Risk Analysis Criteria Development."

Air Cushion Vehicle (ACV) Demonstration

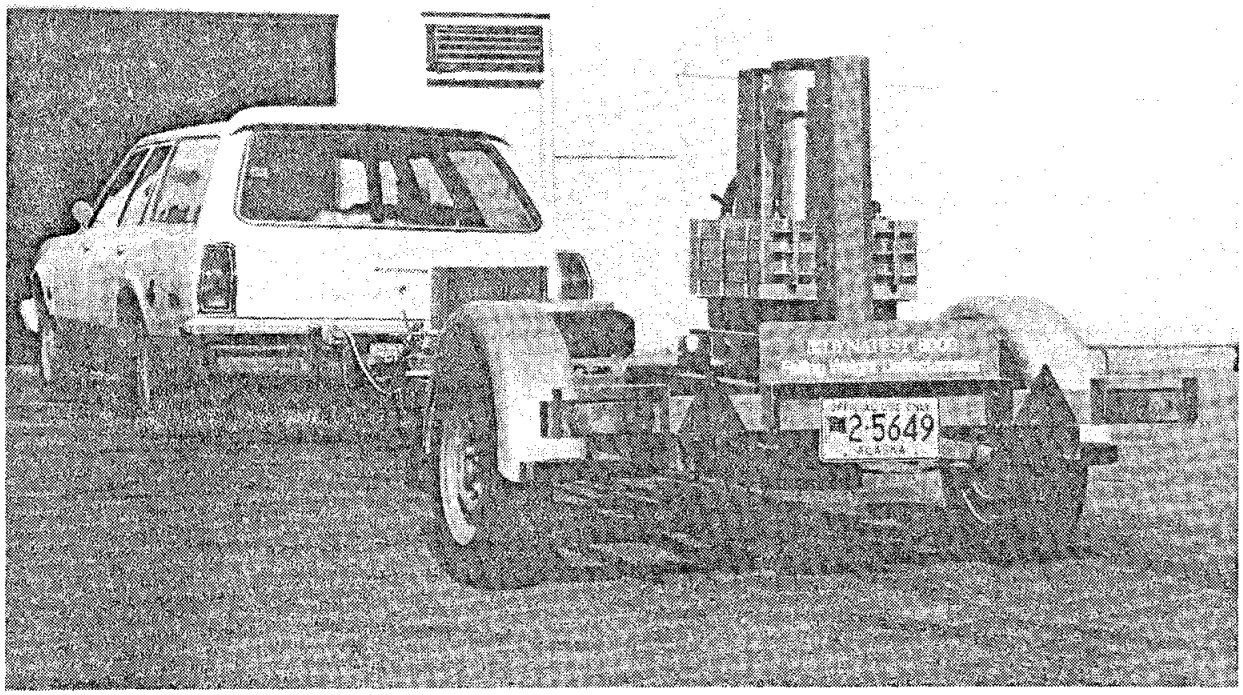
As a result of this demonstration and the five-year Jones Act waiver obtained for ACV use in Alaska, several firms in the private sector have actively pursued the use of ACV's throughout Alaska. The oil and gas industries on the North Slope have had increasing use of this evolving form of transportation technology. Refer to Report No. AK-RD-82-28, "Some Aspects of the Environmental Effects of Air Cushion Vehicle Operations in the Arctic."

Alaska Aviation System Plan, Phase I

The plan developed by consultant TRA/Farr is currently being used by decision-makers to determine the best alternatives available for implementation of significant issues affecting aviation in Alaska. A report on this project is currently in the publication process.

Pulse Light Approach Slope Indicator (PLASI)

As a result of a six-month test in Anchorage, a PLASI was used at the Bethel Airport as an interim solution to an emergency situation that occurred in January 1982 when a "dip" developed within the threshold of the runway, rendering the Visual Approach Slope Indicator (VASI) unusable because of the displaced threshold. Tentative plans are also being made to install PLASI's at several rural airports because of the favorable economics and ease of maintenance exhibited by the PLASI during the test period. A report is currently in the publication process.



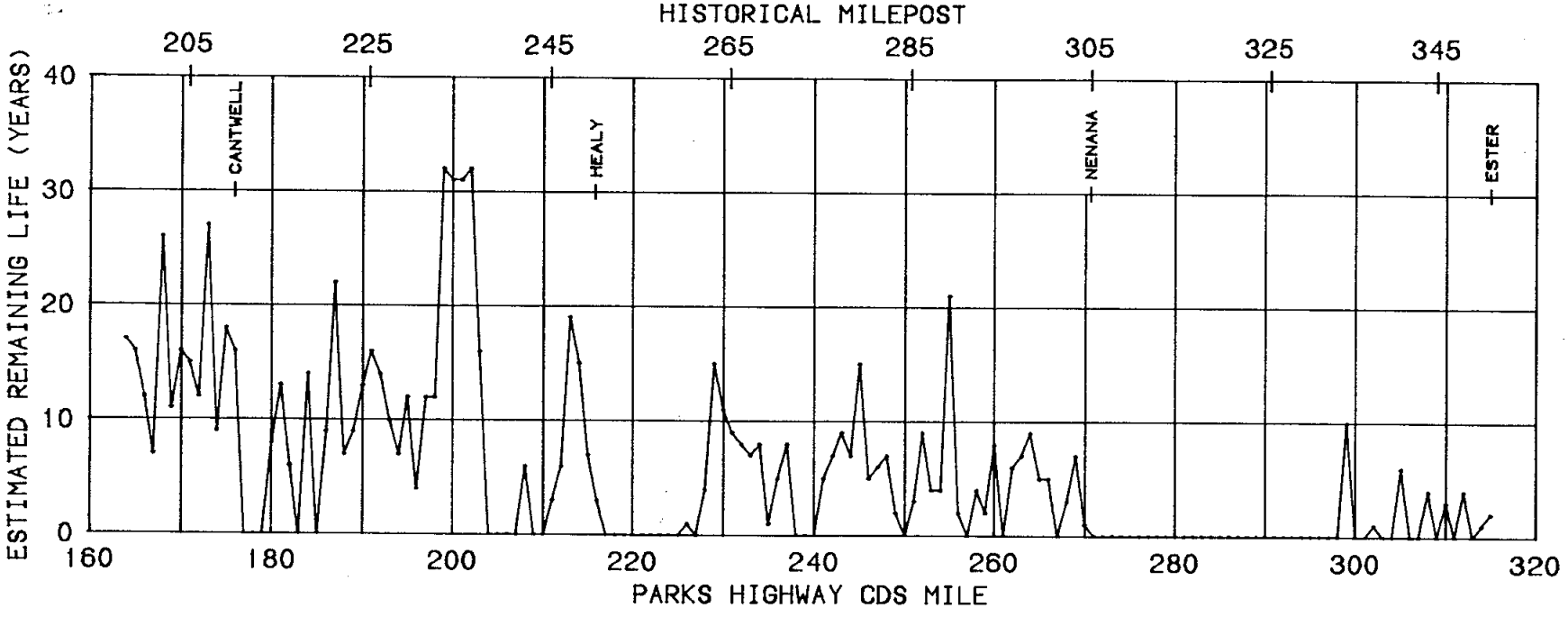
THE FALLING WEIGHT DEFLECTOMETER, A NEW AND POWERFUL TOOL

The Research Section recently purchased a Falling Weight Deflectometer (FWD) to be used to inventory the structural strength of Alaska roadways. The FWD simulates the load imposed on the roadway by a moving truck by dropping a weight on the road surface with a force of 9,000 pounds. The force can be increased to 27,000 pounds so that aircraft landing loads can also be simulated. The deflection or bending of the roadway is measured and reported in much the same manner as the well-known Benkelman Beam technique. However, the FWD also measures pavement movements at five points various distances away from the point of loading, providing much more information on soil strengths at various depths than possible with the Benkelman Beam Technique.

Information obtained from the FWD has a number of important applications to the DOTPF. Load restrictions can be set and removed with greater precision and speed than using traditional methods, pavement life can be estimated allowing advanced planning of overlays and reconstruction, problem areas can be detected before surface distress appears, and overlay thicknesses can be accurately determined based on deflection information.

With the FWD approximately 200 measurements can be made in a day by one person. While the Benkelman Beam test method allows approximately the same production rate, it requires three to four people, a dump truck, and another vehicle. The operating cost for the FWD is approximately 25% less than the cost for the Benkelman Beam crew, and a less hazardous testing condition results.

The plot below illustrates a portion of the Parks Highway from Fairbanks, Alaska, Mile 320 to the Coal Creek area, Mile 150. With a knowledge of the traffic volume over this highway and the deflection information available from the FWD, it is possible to calculate the remaining life of the pavement. It is immediately evident that the portion from Fairbanks to Nenana is in considerably poorer condition than the more southerly portion. With computer modeling it can be calculated that this pavement section has a remaining life of 0 to 10 years. Portions of this pavement have already reached the end of useful life. Other sections of the highway, from Mile 199 to Mile 202 for instance, have a remaining life in excess of 30 years. Positive planning should be done now for strengthening and repaving the northern part of the Parks Highway.



ESTIMATED REMAINING LIFE
PARKS HIGHWAY 1982

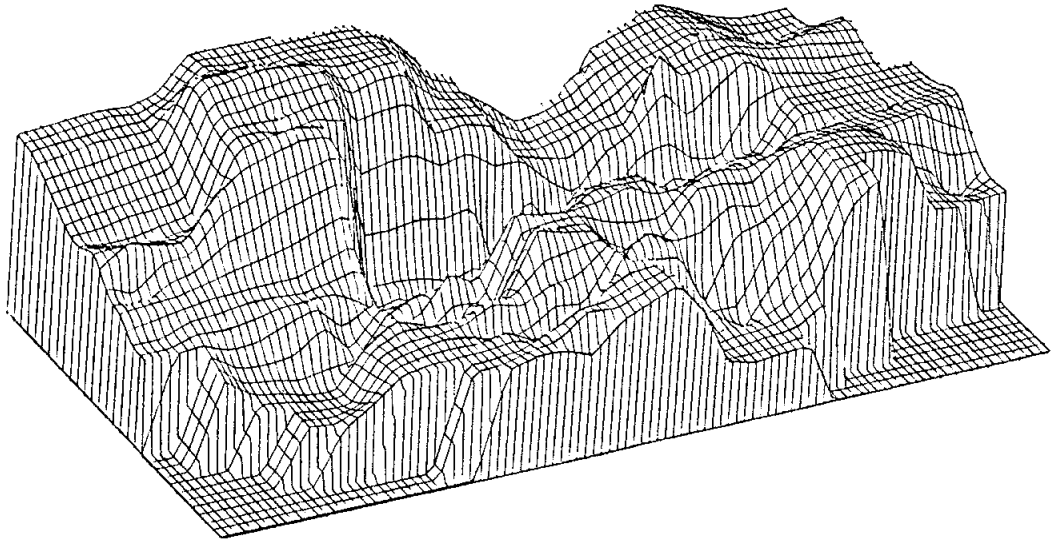
SOIL RESISTIVITY SURVEYS

Soil borings have traditionally provided the principal source of information used in foundation investigations for new roads, runways, and structures. Direct drilling allows for the visual examination and physical testing of borehole samples. While the quality of this information is high, it is very localized in nature and might fail to represent the general soil conditions of the area or miss some anomalous feature that would be of great interest to the designer (such as a mass of ground ice). Drilling is also expensive and in some locations and situations an inconvenient means of soil exploration.

There are now several geophysical mapping techniques that can provide lateral information on subsurface soils. While none of these surface measurement techniques can duplicate the exact nature of borehole sampling, they can be used to supplement drilling programs. Boreholes can then be rationally drilled in locations where ground truth is needed to interpret mappings, and mappings can be used to extrapolate subsurface soil conditions away from borehole sites. Fewer boreholes would be needed in areas where surveys indicate uniform soil conditions, and anomalous features can be flagged for drilling purposes.

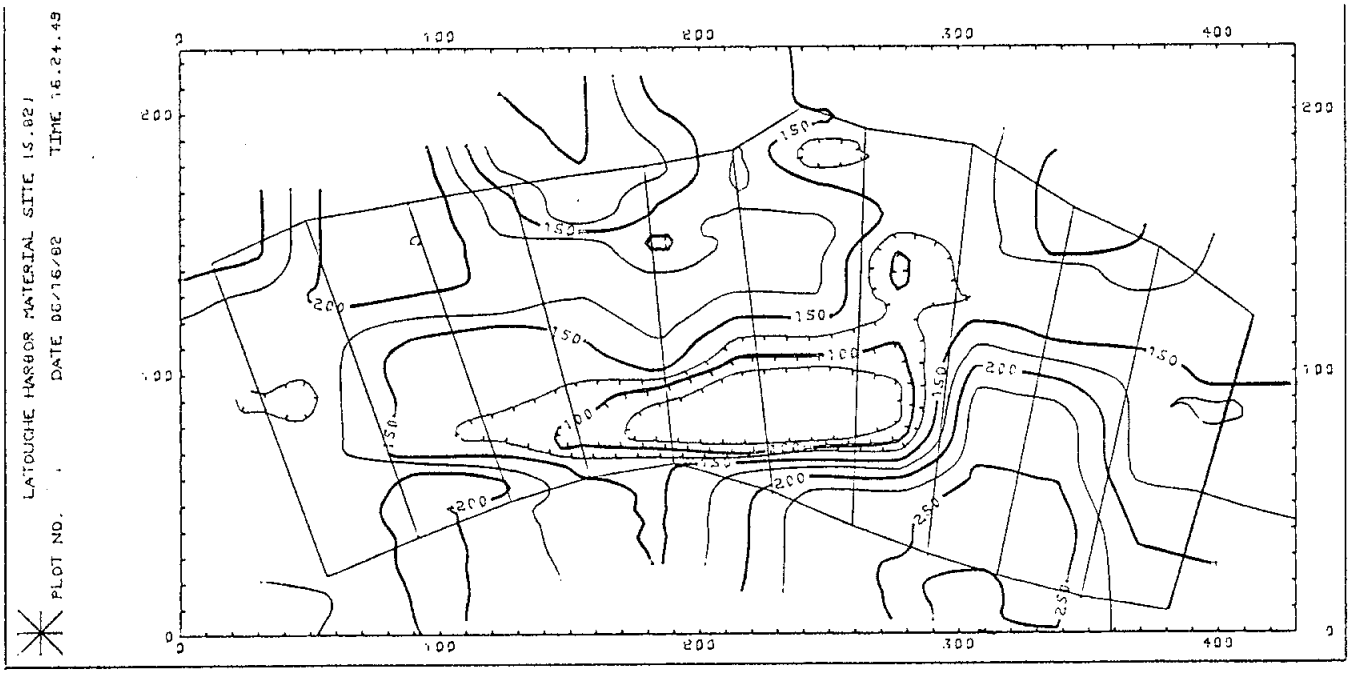
Measurement of the ground's electrical resistance is one geophysical mapping technique that shows promise. Lateral resistivity variations can, in some situations, indicate changing soil types, soil layering, moisture content, and temperature. The practicality of resistivity surveys has improved substantially with the recent availability of noncontact, portable instruments.

Resistivity mappings are now being incorporated into many state-sponsored runway, roadway, and material site investigations. Over the past two years the Research Section has conducted surveys at proposed runways for the villages of Togiak and Marshall. Material site investigations have been performed at Togiak, Ugashik, Latouche Island and along the Alaska Highway near Dot Lake; and two roadway alignments have been surveyed near Northway and Anchorage. These mappings include computerized contours and three-dimensional plots that give a graphic description of subsurface soil conditions and provide a visual means of identifying subtle resistivity variations.



SOIL RESISTIVITY SURVEYS

Hand Held Ground Resistivity Measuring Device



The plots shown are the result of measurements at Latouche Island, Alaska taken in June 1982. They provide some indication of subsurface features and can be used to define borehole locations.

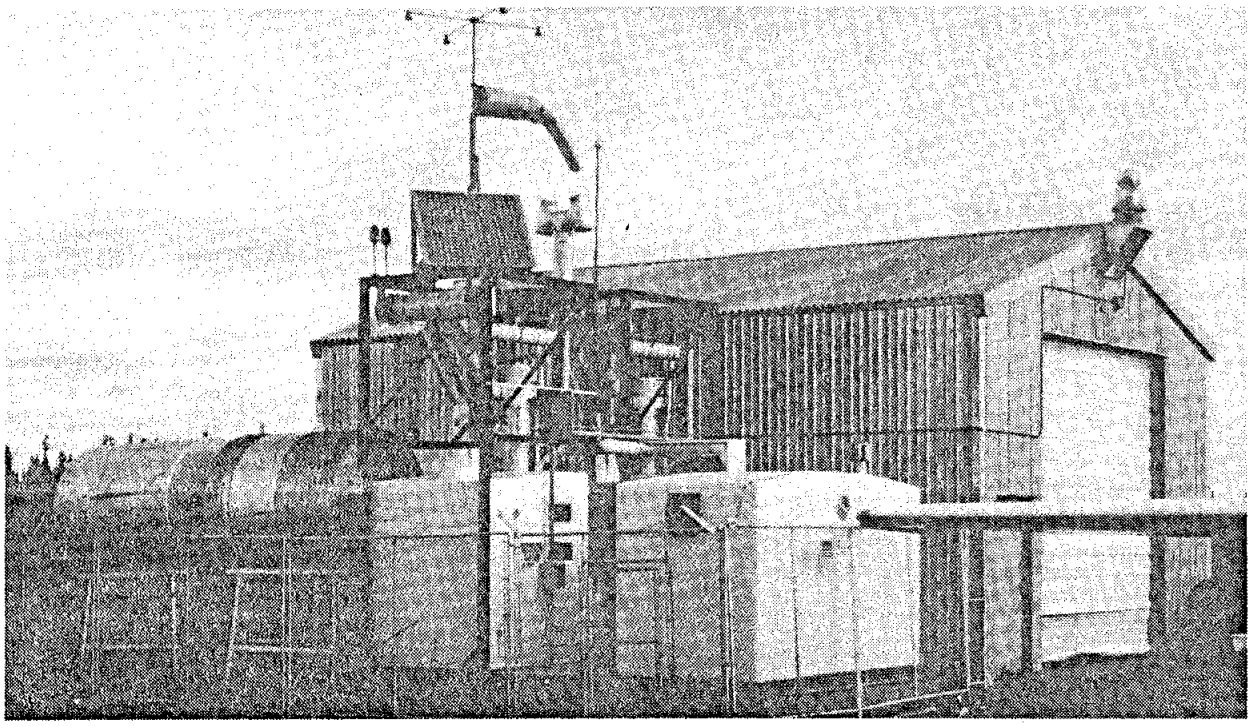
NOORVIK AIRPORT LIGHTING DEMONSTRATION

During the summer and fall of 1979 a research project was conducted to identify and develop a highly reliable, low maintenance electric power supply system as an appropriate alternative to the diesel-electric generator for powering runway lighting systems at rural Alaskan airports. The project used an organic Rankine cycle turbo-electric generator and a large battery bank as primary components. The major advantages of this system are its high reliability, minimal maintenance requirements, and relatively long life (20 years).

In early October 1980 a Federal Aviation Administration approved runway lighting system was installed at the Noorvik Airport using village-supplied electricity as the power source. In late March 1981 two Ormat organic Rankine cycle generators were installed. This project provided a demonstration for comparison of reliability and costs of both power sources and was completed in April 1982.

As a direct result of this demonstration project, Ormat generators will be used to power runway lighting at several other rural Alaskan airports in the near future. These turbines proved to be a highly reliable, low maintenance electric power supply and are recommended for use to provide runway lighting at rural airports where local power is not available. A final report should be available in the fall 1982.

Previous to the installation of FAA approved lights, Noorvik used the "firepot" technique for emergency lighting. The new lights are turned on and controlled by the pilot of an incoming aircraft and remain lit for 15 minutes. The photo shows the two Ormat Turbine Modules and fuel tanks located beside the airport storage building.



SOLAR ASSISTED CULVERT THAWING DEVICE

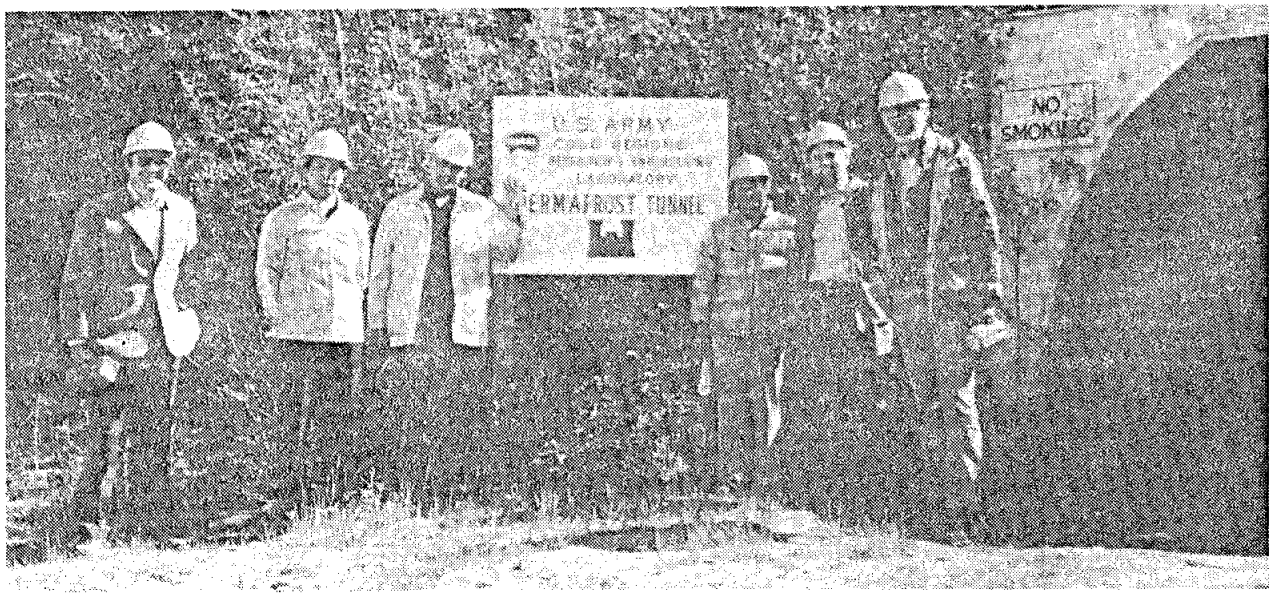
A continually recurring springtime problem is icing of highway culverts during spring breakup. Previous methods of attempting to solve this problem have included electric resistence heating, daily circulating of steam or hot water, and the familiar 55-gallon drum oil burner placed at the entry end of a culvert to keep it flowing. The Solar Assisted Culvert Thawing Device shown above is model two of a project that has yielded effective results. A solar panel generates enough electricity to power a small pump which circulates water through the culvert. The water is heated by a linear parabolic solar collector designed to be effective against vandal's bullets.

THIRD INTERNATIONAL SYMPOSIUM ON GROUND FREEZING

The Third International Symposium on Ground Freezing jointly sponsored by the Department of Transportation and Public Facilities and the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) was held June 21-24, 1982 at Hanover, New Hampshire. The conference was specifically directed to the engineering aspects of artificially freezing of ground to aid in the construction of tunnels under rivers, railroad and highway underpasses and mining applications. These construction practices are closely related to permafrost problems encountered in highway and building foundations in Alaska. The process of artificially freezing ground results in many of the familiar frost heave construction problems experienced on Alaskan permafrost.

Following the technical sessions in New Hampshire, a series of field trips were conducted in Alaska. Trips included visits to the large open pit Usibelli Coal Mine at Healy, Alaska and the nearby Golden Valley Electric Association mine-mouth power plant. Tours through the CRREL Permafrost Tunnel and Northwest Gas Pipeline Company Frost Heave Test Facility near Fairbanks provided graphic examples of the complexity of frozen ground construction. A trip to the Sohio Oil Company facilities at Prudhoe Bay examined the technical problems encountered daily by large oil and gas engineering activities on permafrost.

The Ground Freezing Conference was attended by national and international experts and included technical papers from 16 different countries.



Participants in the Third International Conference on Ground Freezing visit the U.S. Army Cold Regions Research and Engineering Laboratory's Permafrost Tunnel near Fairbanks. Left to right, Robert Venusti, Alaska DOTPF; Dr. T. Hirano, Kajima Institute of Construction Technology, Tokyo; Dr. Fred Radd, Conoco Oil Corporation; Dr. M. Tanaka, Kajima Institute of Construction Technology, Tokyo; Dr. Hans Jessberger, Rhur University, Bochum, West Germany; Larry Sweet, Alaska DOTPF.

SECTION 5
PUBLICATIONS

Listed below are the publications produced by the Research Section since July 1, 1980.

All Department of Transportation and Public Facilities Research Publications are available on microfiche from:

Arctic Environmental Information and Data Center
University of Alaska
707 'A' Street
Anchorage, Alaska 99501
(907)279-4523

REPORT NO.	TITLE
AK-RD-80-1	Jurick, R., Automated Pavement Rut Depth Measuring System, 43 pp., 1980.
AK-RD-80-2	Wentink, T., Alaska Wind Power User's Manual, 1st Edition, 101 pp., 1980.
AK-RD-80-3	Hawkins, D.B., Gas-sorptive Properties of the Zeolite Mordenite, Interim Report, 13 pp., 1980.
AK-RD-80-4	Tiedemann, J.B., Airship Operation in Alaska, 17 pp., 1980.
AK-RD-80-5	Miller, R.E., and D. Pruhs, Strobe Lighting Demonstration Project at St. Michael, Alaska, 32 pp., 1980.
AK-RD-80-6	Roberts, T.D., R.P. Merritt, and K.J. Kokjer, Low Data Rate Digital Transmission Techniques for Alaskan Applications, 31 pp., 1981.
FHWA-AK-RD-81-7	McHattie, R., B. Connor, and D. Esch, Pavement Structure Evaluation of Alaskan Highways, 208 pp., 1980.
FHWA-AK-RD-81-8	Connor, B., Rational Seasonal Load Restrictions and Overload Permits, 52 pp., 1980.
FHWA-AK-RD-81-9	Esch, D., R. McHattie, and B. Connor, Frost Susceptibility Ratings and Pavement Structure Performance, 42 pp., 1980.
AK-RD-81-10	Seifert, R.D., Passive Solar Alaskan School, Report on Phase I, 212 pp., 1981.
AK-RD-81-11	Seifert, R.D., Passive Solar Fire Station Demonstration Project, Interim Report, 21 pp., 1981.

AK-RD-81-12 Zarling, J.P., Air-To-Air Heat Recovery Devices for Small Buildings, Interim Report, 19 pp., 1981.

AK-RD-81-13 Rezek, J.F., and R. Jurick, Tracer Gas for Meteorological Analysis in the Fairbanks Basin, 33 pp., 1981.

AK-RD-81-14 Carlson, R.F., and C. Hok, Improvement of the Fairbanks Atmospheric Carbon Monoxide Model -- A Program for Calibration, Verification, and Implementation, 74 pp., 1980.

AK-RD-81-15 Zarling, J.P., Passive Solar Heating in Alaska, 20 pp., 1980.

AK-RD-81-16 Jurick, R., and J. Murray, Implementation of the Governor's Haul Road Policy; Intra-Agency Communication Needs, 37 pp., 1981.

AK-RD-81-17 Peratrovich & Nottingham, Inc., Use of Yukon River Bridge Risk Analysis Criteria Development, 32 pp., 1981.

AK-RD-81-18 DOTPF Research Section, Research Procedures Manual, 76 pp., 1981.

AK-RD-81-19 Zarling, J.P., and J.S. Strandberg, A Thermal Performance Design Optimization Study for Small Alaskan Rural Schools, DRAFT, 162 pp., 1981.

AK-RD-81-20 Schnurr, L., Inter-Exchange Radio Trunking Using HF Circuits, 52 pp., 1980.

AK-RD-81-21 DOTPF Research Section, Annual Report to the Director-FY81, 51 pp.

AK-RD-82-1 Seifert, R.D., A Solar Design Manual for Alaska, 168 pp., 1981.

FHWA-AK-RD-82-2 McHattie, R., Asphalt Concrete Properties and Performance in Alaska, 214 pp., 1981.

FHWA-AK-RD-82-2A McHattie, R., Asphalt Concrete Properties and Performance in Alaska, Executive Summary, 15 pp., 1982.

AK-RD-82-3 Reckard, M., and M. Newell, Alaskan Wind Energy Handbook, 154 pp., 1981.

AK-RD-82-4 Roberts, T.D., Meteor Burst Demonstration Project, Interim Report, 8 pp., 1981.

AK-RD-82-5 Rezek, J., Halon Fire Suppression System Demonstration for the Alaskan Bush, Interim Report, 9 pp., 1981.

AK-RD-82-6 Esch, D., R. McHattie, Prediction of Roadway Strength from Soil Properties, 18 pp., 1982.

FHWA-AK-RD-82-7 Phukan, A., A Literature Search for Substitute Materials in Frost Protecting Layers, 58 pp., 1981.

FHWA-AK-RD-82-8 Henry, J.W., Pavement Problems in Alaska Versus Asphalt Gradings, 53 pp., 1981.

FHWA-AK-RD-82-9 Connor, B., Performance of Bituminous Surface Treatments in Alaska, 89 pp., 1982.

AK-RD-82-10 Zarling, J.P., and F. Miller, Solar Assisted Culvert Thawing Device, 28 pp., 1982.

AK-RD-82-11 Tiedemann, J.B., and R. Jurick, Maintenance Monitoring for Remote Public Facilities -- A Feasibility Study, 17 pp., 1981.

AK-RD-82-12 Kawasaki, K.J., and T.E. Osterkamp, Impulse Radar Familiarization and Testing on Road Sites in the Fairbanks Area, 16 pp., 1981.

FHWA-AK-RD-82-13 Gruol, V., K.J. Kawasaki, and T.E. Osterkamp, Field Evaluation Site for Ground Ice Detection, 30 pp., 1982.

AK-RD-82-14 Connor, B., and C.W. Gentry, Compilation of Highway Maintenance Costs, 141 pp., 1981.

FHWA-AK-RD-82-15 McHattie, R., Description and Evaluation of the Alaskan Pavement Rating Procedure, 79 pp., 1982.

AK-RD-82-16 Connor, B., C.W. Gentry, and TRA/Farr, Compilation of Highway and Airport Maintenance Costs, 306 pp., 1982.

AK-RD-82-17 Esch, D., Construction and Benefits of Rubber-Modified Asphalt Pavements, Presented at Annual TRB Meeting, 40 pp., 1982.

AK-RD-82-18 Strandberg, J.S., Two Rivers Passive Solar Design Analysis, 54 pp., 1982.

AK-RD-82-19 Elias, V., and E.G. Johnson, The Use of A Reinforced Earth Slab to Reduce Embankment Loads at Auke Bay, Alaska, 25 pp., 1982.

FHWA-AK-RD-82-20 Rezek, John, Gasohol as a Vehicle Fuel in Sub-Arctic Climates, 26 pp., 1982.

AK-RD-82-21 Kinney, T., Use of Geotextiles to Bridge Thermokarsts, 33 pp., 1981.

AK-RD-82-22 Kawasaki, K., T.E. Osterkamp, and J.P. Gosink, A Preliminary Evaluation of Numerical Models Suitable for Thermal Analysis of Roadways and Airstrips, 17 pp., 1982.

AK-RD-82-23 Zarling, John, Air-to-Air Heat Recovery Devices for Small Buildings, Final Report, 50 pp., 1982.

AK-RD-82-24 Rezek, John, New Product Evaluation: Ceramic Insulation, 1982.

AK-RD-82-25 Reckard, Matt, Use of Sun Spaces in Alaska, 1982.

AK-RD-82-26 Connor, Billy, and Dick Gaffi, Optimum Sand Specifications for Roadway Ice Control, 1982.

AK-RD-82-27 Hawkins, D.B., Gas-Sorptive Properties of Alaska Zeolites, 16 pp., 1982.

AK-RD-82-28 Fancy, Steve G., Some Aspects of the Environmental Effects of Air Cushion Vehicle Operations in the Arctic, 30 pp., 1982.

AK-RD-82-29 DOTPF Research Section, Summary of Research - FY82, 1982.

ACKNOWLEDGEMENTS

During this past year the Research Section has received assistance and cooperation from many individuals within the Department, from state and federal agencies, and from companies in private industry. These contributions to the objectives of the Department are appreciated.

A special acknowledgement is extended to Mr. Heinrich Springer who resigned in April, 1982 from the position of Director of the Division of Planning and Programming in the Interior Region. Henry Springer was always a strong supporter of research and helped build the Research Section into what it is today.